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Cement & Concrete Association of New Zealand

Hydrated Cement Treated Crushed Rock Base – Study Tour

Perth, Australia

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Introduction

Dr. Greg Arnold (PaveSpec Ltd.) in association with the Cement and Concrete Association of New Zealand (CCANZ) arranged a study tour to Western Australia to view the manufacture and construction of Hydrated Cement Treated Crushed Rock Base (HCTCRB). The purpose of the study tour was to benefit to the New Zealand roading industry through providing a group of New Zealand engineers with knowledge on HCTRB manufacture and use.

Appendix 1 lists the attendees on the study tour. There were 18 attendees in total, comprising representatives from:

- Road Controlling Authorities (Transit New Zealand & a District Council)
- Roading Consultants
- Roading Contractors
- Road Metal Suppliers (quarries)
- Cement Suppliers

Appendix 1 also lists the main contacts from Perth.

Background (Greg Arnold)

Due to the poor performance of crushed rock base (CRB) on various roads within the Perth metropolitan area, a project was undertaken to investigate ways of improving stiffness and reducing moisture sensitivity of the CRB. The project involved the use of repeated load triaxial testing equipment within laboratory conditions.

The testing indicated that small amounts of cement significantly improved the materials resistance to deformation when wet. It was also revealed that the small quantity of cement could be added to the CRB *at* the quarry and stockpiled for a minimum of 7 days for hydration to occur. The CRB containing cement was then turned over, then loaded onto trucks and used as a normal crushed rock base.

This method of adding cement to CRB and stockpiling it for hydration to occur resulted in improved resistance to deformation when wet. In addition, there are significant advantages in manufacturing HCTCRB, such as the absence of time constraints in terms of placement, and the reduced risk of the material becoming excessively stiff and cracking.

Transit New Zealand has expressed interest in this method of adding cement to a basecourse aggregate, stockpiling for hydration to occur and then using as a basecourse with improved resistance to deformation/rutting. The Transit New Zealand Supplement to the Austroads Pavement Design Guide classifies the HCTCRB manufactured in Perth as a *modified aggregate*. Modified aggregates are recommended in the New Zealand Supplement for use in high trafficked state highways as an economical alternative to structural asphalt.

Transit New Zealand also believe a market exists for lower quality aggregates, that previously failed to meet their specifications. The modification of lower quality

aggregates through the addition of cement will improve performance and therefore permit their use.

Over the next year Transit New Zealand will be developing a Repeated Load Triaxial (RLT) test. This test will involve the use of a device that simulates repeated wheel loadings, and is based on recently completed research of aggregates, modified or otherwise, to determine their suitability for use in high, medium or low trafficked roads, in either wet or dry conditions.

A technical note on the Repeated Load Triaxial (RLT) testing is attached as ***Appendix 2***.

Study Tour Itinerary

The study tour itinerary, prepared by staff from Main Roads Western Australia (MRWA), is attached as ***Appendix 3***.

The inspection of the trial areas at Reid Highway took place on Wednesday 11 October. The scheduled observation of an HCTBRB layer under construction, originally planned for Wednesday 11 October, was cancelled due to adverse weather conditions.

Tour – Main Sites of Call:

MRWA Office
- Introduction and briefing by MRWA staff

CSRE Quarry
- Quarry tour and briefing by CSRE staff
- Crushed Rock Base production
- HCTCRB stockpiled product

Boral's Quarry
- Quarry tour and briefing by Boral staff
- HCTCRB production (short run) and stockpiled product
- Concrete Waster Rock Base (CWRB) stockpiles

Reid Highway Trials
- Site inspection of full-scale trial areas

Major Metro Road
- Construction: Rained off

Various MRWA locations
- Pavement inspections

MRWA Office
- Various presentations

MRWA Laboratory

- Inspection of testing facilities, equipment, and various road-making materials

Perth – Notes on Site Visits

Gosnells Quarry - Briefing by Plant Manager

2% cement is added to 28mm down crushed rock base (note: grading results of the material indicated that the material was in fact 19mm down – see ***Appendix 5***), and mixed in a pugmill. Water can be added, as required, at the pugmill. The pugmill has a maximum production of 500 to 600 tonnes/day.

Approx 5% of low PI clay is added to normal CRB, and to the CRB that is treated with cement to produce HCTCRB. The clay improves workability and cohesion, holds added moisture, and aids compaction.

After the material is produced by the pugmill, it is stockpiled for a day, moved, and stockpiled for a further 7 days, before being used for construction. The "shelf-life" of the material in the second stockpile is 90 days. This "shelf-life" was extended from 28 days to 90 days after some experience was gained with the material. [The longer shelf-life reduces the dry-back time, but quarry operators are reluctant to have material stockpiled in their quarries for this length of time].

The pugmill is cleaned with a jackhammer about once per week when HCTCRB is being produced.

For quality control purposes, the Linear Shrinkage test is preferred to Plasticity tests, as it has better reproducibility. The Liquid Limit test is also used.

HCTCRB sells for Au$30-35/ tonne, while CRB sells for Au$10-11/ tonne. As these figures illustrate, treating the CRB to produce HCTCRB adds value to "run-of-the-mill" CRB.

Boral's Quarry - Briefing by Plant Manager

Boral have two methods of adding value to its (98% passing 19mm) CRB:

1. Waste concrete, collected from 9 nearby ready mix plants is mixed with CRB, to produces a Concrete Waste Road Base (CWRB). Approximately 25% concrete waste (i.e. surplus concrete returned to the plant in transit trucks) is blended with 75% CRB. The concrete waste is collected – as a backload in quarry trucks - from the ready mix plants after it has been stockpiled for a few days. CWRB is produced by spreading waste concrete below a quarry face, blasting the face, then mixing the waste concrete and crushed rock blend in a pugmill. Sometimes a small amount of additional cement is added during mixing.

   The advantages of producing CWRB are threefold:

- By using concrete waste in the quarry, the ready mix concrete plant saves on having to dispose of the material in an environmentally friendly (and legal) way, for example, in a landfill site – hence saving tipping costs.

- By adding concrete waste, the payload tonnage of the CRB is increased.

- CWRB adds value to the price of CRB.

- A better road making material is produced.

CWRB is not used on MRWA projects, but rather on smaller local roads.

2. HCTCRB is produced in a similar manner to that in Gosnells quarry, except clay is not added to the CRB.

   Boral's plant produces just over one million tonnes per annum, and the pugmill can produce up to 500 t/hr of HCTCRB.

MRWA - Briefing by Pavement Engineering Staff (SKG, SH and GW)

Trial Areas

There were nine test sections on Reid Highway where five different materials were used – some at different combinations of depth, as follows:

- 100 mm HCTCRB (2% cement)
- 100 mm Bitumen Stabilised Limestone (2% bitumen)*
- 100 mm Crushed Rock Base
- 200 mm Crushed Rock Base
- 200 mm HCTCRB (1% cement)
- 200 mm HCTCRB (2% cement)
- 200 mm HCTCRB (0.75% cement)
- 200 mm Cement Stabilised Limestone (2% cement)
- 200 mm LIMUD (- Lime mud)

The trial areas were constructed approximately nine years ago.

The best performing section was the *Bitumen Stabilised Limestone area, but this was also the most expensive section to construct.

Some of the HCTCRB sections started cracking after six years. This phenomenon is currently under investigation.

For full details of the trial and test sections see ***Pavement Engineering Report No. 2004/17M*** – see ***Appendix 4*** of this report.

General (HCTCRB)

HCTCRB provides excellent resistance to rutting and prevents the formation of potholes.

HCTCRB reduces the dryback period – the period between final compaction of the basecourse and the construction of the surfacing layer(s). [HCTCRB needs only to be dried back to 85%, while CRB is dried back to 60% OMC].

All MRWA roads with high traffic volumes (i.e. over 1 x 10^7 Equivalent Standard Axel's) are now constructed with HCTCRB.

HCTCRB surfaces need to be primed prior to the application of asphalt.

General (Other)

RLT testing provides an excellent prediction of rutting performance.

Open Grades Porous Asphalt (OGPA) clogged up after about three years. [In Western Australia, the OGPA is not maintained].

Stone Metric Asphalt (SMA) is not used – or anticipated to be used – on major highways.

Smaller maximum size aggregate SMA (i.e. 7 or 10 mm c.f. 14 mm) provides enhanced noise reduction, but is inferior to OGPA.

There was a 7% densification of SMA in its first year.

SMA should not be used on roundabouts or where maneuverability is important, as skid resistance in early ages (up to 20 months in low traffic areas) is poor.